California Institute of Food and Agricultural Research Survey on Energy Management in the Food Industry

Part I-a: Executive Summary

Purpose: The goal of the project was to establish a baseline of information about energy issues in the agri-industrial processing sector and assess how energy management practices can increase profitability in a restructured electricity market. The project goals were to determine what specific issues were important to industry managers; to assess the energy ramifications of potential solutions to industry problems; and to define what government services can be of use to the industry. The following specific objectives were identified.

1. Identify the key processes in which the energy is being utilized and where conservation measures could be implemented.
2. Identify key decision-makers and summarize their behavior and attitude toward energy efficiency.
3. Measure key decision-makers' knowledge and perceptions of current practices and existing programs promoting energy efficiency.
4. Measure key decision-makers' preferences for energy efficiency incentives, both existing and conceptual.

The objectives were met by the use of a mail survey and a personal interview survey. The mail survey was developed through collaboration with various sectors within the food industry by recruiting focus teams. The personal interview survey was implemented to explore the issues of a qualitative nature that were too complex to address in the mail survey. Both surveys were reviewed and drafted with the assistance of the California Energy Commission.

Findings:

The survey investigated the following topic areas related to energy:

Energy Management Practices and Barriers
Future Energy Demand
Current and Future Technologies
Power Reliability
Technology Acquisition
Labor
Regulatory Issues
Consolidation and Relocation

<u>Human Resources for Energy Management</u>

Companies with 500+ employees or with energy bills over $1 million annually have at least one person dedicated to managing energy. Designated energy managers, however, often have other responsibilities in plant management, procurement, or engineering.

<u>Lack of System Optimization</u>

Only 22% of the plants responding to the survey practiced total plant optimization, and companies with slow growth rates were more likely to utilize this tool of analysis.

<u>Sourcing Expertise and Information</u>

Energy services contracts were used by 34% of the industry, mainly among processors with 500+ employees.

Barriers

The two most common barriers identified were 1) further investments in energy efficiency can't be justified economically (26%) and 2) there is lack of resources to evaluate investments (26%). Lack of incentive to optimize was not a barrier.

Purchasing

Rate management is widely practiced and interruptible rates were elected by 38% of the survey population, a surprising result in view of the cost of power interruption to most food processing operations.

Energy Demand Expected to Increase

Energy demand was predicted to increase by 72% of the respondents. Similarly, 74% indicated that managing energy consumption would be more important in the future.

Areas of Operation Already Optimized

Use of energy for overall air quality mitigation, and overall solid waste treatment was estimated as decreasing for a small group of respondents. Some of these companies have recently upgraded their technology in this area to more energy efficient types.

Large vs. Small

Companies with 500+ employees exhibited more interest in the listed technologies than small companies. Large companies are currently using more of these technologies.

Benefits of New Technology

The most frequently cited benefits of new technology were "cost reduction" (31%) and "improved product quality" (25%).

Technologies Used Now

The survey clearly indicates that variable frequency drives (52%) and microprocessors (46%) are widely utilized in the food processing industry. Write-in responses were given as the "most valuable new technology". Of these, 37% were energy efficient technologies such as variable speed drives, programmable logic controllers, and other microprocessor-controllers for energy. The next 25% were automated labor saving devices, and 15% were for regulatory compliance. Packaging is also an important area as consumers demand more convenience (12%).

Technologies Generating Interest for the Future

Robotics (16%) and reverse osmosis (16%) have been acquired and are generating additional interest as future technologies (12% each). Both of these technologies imply an increase in future energy usage.

Emerging Technologies for Food Preservation

Emerging technologies, including freeze concentration, Ohmic heating, pulsed electric field, irradiation and written pole motors have not been widely incorporated, although 7% responded that irradiation was a technology they would evaluate in the future. When food

safety is at stake, the industry is cautious about adopting new technologies, and regulatory agencies are slow to approve technologies until they have been thoroughly demonstrated.

Frequency and Costs of Interruptions
The average number of outages per facility was 5.2 and the average cost per outage was $70,409.

Power Reliability is the Responsibility of the Utility
The most common response to a power interruption or power fluctuation is to call the utility representative and demand an explanation. Utility representatives who address these issues agreed that the responsibility for determining the cause of any quality or reliability problems falls back on the utility. The utilities reported that in these cases the end-user is most often the cause of the problem.

Credibility Issues
Food industry managers stated that the most credible sources of information are from their own colleagues in the industry with similar bottom-line responsibilities. Industry publications are the second most credible source of information.

Costs Associated with Labor
Investments that reduce labor costs receive a great deal of attention, since California's labor costs are viewed as higher than other states.

Elimination of Labor Costs
Two areas in which labor costs have been eliminated are harvesting and sorting of raw material.

Work Ethic
California workers were described as less committed to job and company than in other regions of the nation.

Trade Positions Difficult to Fill
The most difficult positions to fill and retain in food industry operations are plant electricians and skilled maintenance personnel.

Training Preferences
Seminars were more desirable than written materials or videos. Utility-sponsored seminars were frequently mentioned, and committee meetings of the California League of Food Processors.

Regulatory Issues and Community
Some food processors that have recently optimized do not see technology currently available to reduce boiler emissions further, or what they see is not cost-effective. The working relationship with the environmental community has improved over the last ten years, as a result of a mutual education process. Food processors viewed the California Energy Commission's (CEC) influence as practically nonexistent in terms of their interests.

Acquisition of New Technology

An acceptable payback period for new technologies ranged from 2 to 3 years. Typically, projects have an energy efficiency component are viewed as having a long payback period. For companies that process seasonally, this makes payback time longer. The shorter the payback period, the easier it is to get the project approved therefore the projects that get done first have the shortest payback time.

Rebates

Processors cited several reasons that processors use rebates, including peer pressure, competitive pressure, and because the equipment needed replacement anyway. Vendors were observed to benefit more from rebate programs than the buyers.

Consolidation and Relocation

As urban landscapes swallow up agricultural land, changes in the landscape have pressed processing plants to relocate.

Part II-b: Results and Statistical Analysis of Survey Responses

A. ENERGY MANAGEMENT PRACTICES

The survey indicates that SIC sector is not related to any particular energy management practice with two exceptions: 1) Fruit and vegetable processing had a much higher rate of participation in educational workshops and classes for energy management, and for services arranged by a utility representative. 2) Fruit and vegetable processing is the only sector that indicated participation in Department of Energy programs. This correlation is attributed to the activities of the California League of Food Processors (CLFP), which is comprised of companies in this sector. CLFP is very active in organizing workshops and meetings for member education and advocacy on issues of importance to food processors, including energy.

A large majority of respondents use regular maintenance to help manage energy. While less than half use any other specific management practices. The following table presents the percent of respondents using specific practices.

Energy Management Practices

regularly scheduled maintenance	84%
monitor output to energy use	43%
energy audits	43%
rebates	43%
info from equip suppliers	41%
service from utility sales	40%
energy services contract	34%
workshops & classes	33%
procurement policies	30%
staff training	28%
total plant optimization	22%
electronic management systems	19%
employee on energy 50%+	12%
co-generation	10%
Motor Challenge & Nice3	6%
Climate Wise	4%
employee incentives	2%
mobile membrane trailer	2%

<u>Write-in Responses for Energy Management Practices</u>

insulation blankets to tanks
hired consultant, split savings
installed substations to reduce power costs
we spend $ to optimize
new plant
staff commitment to policies of energy efficiency
reducing costs, increase energy efficiency
track cost to individual group of products or product class

have optimized, environmental is additional cost but not large
third party consultant
thermographic survey of electrical equip
power interruption costs more any of the above factors
transmission metering for electricity and gas

Statistical Analysis of Energy Management

The strongest determinants of having energy practices in place are company size by number of employees and the amount of the company energy bill. Statistical analysis showed a correlation between these two variables and the following practices: monitoring product output in terms of energy use; contracts with energy service companies; procurement policies; education; rebates; and services from the utility. Following are the statistical results in more detail.

Large companies are more likely to have at least one employee spending 50% or more time on energy management ($p<0.005$), and are more likely to do energy audits ($p<0.007$).

The companies who use total plant operation optimization practices were more likely to be slower growth companies ($p<0.01$), and of a large size ($p<0.10$). There was no relationship to the size of their energy bills.

Companies with high growth rates were more likely to get information and training from equipment suppliers ($p<0.10$).

Barriers

The survey asked the respondents "What is the primary barrier that prevents your company from optimizing energy efficiency, (Check only one, the most important reason)"

Barriers to Energy Optimization

Improvements are too costly to pay for themselves	26%
Lack of staff and resources to evaluate our energy usage	26%
Energy usage fluctuates seasonally	17%
Energy costs are low so it is low priority	16%
Lack of information to become more efficient	8%
Environmental regulations prevent optimization	4%
Lack of incentive, management doesn't reward the effort	3%

Some respondents wrote in their own barriers to optimization:

Write In Responses
government regulations demand energy use
busy with expansion priorities
rapid growth has used all resources
relocate soon so payback will not return
lack of funds
plants operate 24 hrs, 7 days

Statistical Analysis of Barriers

Low energy bills were weakly related to lack of priority on energy optimization ($p<0.10$)

Similarly, companies indicating that their percent energy cost (as a percent of total product cost) is low; also viewed optimizing energy use as low priority ($p<0.01$)

Large companies are most likely to find that, after evaluation, energy efficiency improvements are too costly to pay for themselves ($p<0.05$)

As company size decreases ($p<0.01$), or as the energy costs increases ($p<0.10$), seasonal fluctuations in energy use are more likely to be the primary barrier to optimizing energy use.

Purchasing

The food industry uses a number of complex purchasing strategies for natural gas, however most of the choices below apply to electricity.

Purchasing Strategies

Review with utility or marketer	64%
Interruptible rate	38%
Off peak rate	37%
Consultant	23%
Economic development rate	9%
State and federal lobbying	9%
Formation of utility	6%
Retention rate	1%

Write In Purchasing Strategies

purchase of low BTU N.G. at reduced cost from local gas well
optimal billing *(note: a new billing option arranged by the canning industry to spread seasonal bills over a longer period)*
several facilities under one contract
own transformers
not receiving any discounts

Statistical Analysis of Purchasing

The larger the company, the more likely the company was to regularly review and evaluate rate schedules with the utility rep or energy marketer ($p<0.0001$). This was also true in terms of the energy bill, the larger, the more likely to use this practice ($p<0.004$).

Off peak time-of-use discounts are more frequently used by large companies ($p<0.10$) with large energy bills ($p<0.05$).

Large companies are more likely to use interruptible rates ($p<0.0001$).

Only companies with large energy bills got involved in state or federal lobbying (observation).

End-users buying from municipal utilities used more off-peak, time of use discounts ($p<0.01$), and both municipal utilities and SCE were more likely to use an interruptible rate program than PG&E customers were ($p<0.01$).

Expected Future Course of Action (Electricity purchasing)

Remain with current supplier	39%
Direct Access	39%
Don't know	24%
Join aggregator	12%
Join cooperative	12%

Write in Course of Action
help develop competitive sources
would like to buy from South Lake Tahoe area, rates lower than PGE
deregulated 3rd party natural gas purchasing
electric power purchase contract
consolidate facilities & contract for multiple sites
become primary user
PGE interruptible economics dictate change
changed to MID
evaluate all cost effective strategies
compare prices
shop rates
need further information
waiting for the market to settle before I choose the direction we will go
only pay .0415 KwH, good for CA

Large companies were more likely to anticipate using direct access to a new supplier ($p<0.05$) and total energy bills ($p<0.01$).

Small companies ($p<0.05$) or companies with small energy bills ($p<0.01$) were most likely to select "don't know" as a response.

B. FUTURE USE OF ENERGY

A list of processes was provided, respondents were asked to check boxes to indicate if energy for that process would decrease, remain the same, or increase for that process over the next 5 years. The following table reports the results sorted according to the processes that are expected to increase:

USE OF ENERGY FOR THESE PROCESSES WILL:	decrease	same	increase	Not applicable	Total
overall processing	4	24	79	1	108
automation	2	19	77	6	104
heating, cooling, boilers, heat exchangers	4	29	68	7	108
packaging	0	30	66	9	105
sanitation	2	33	65	5	105
conveying	0	40	61	5	106
pumping	3	29	56	17	105
overall water disposal & treatment	3	32	55	16	106
lighting	3	64	54	3	124
overall solid waste disposal & treatment	5	35	46	22	108
Pasteurization / sterilization	0	26	43	36	105
cooling (HVAC)	1	58	40	8	107
proprietary	0	27	38	37	102
overall air quality mitigation	3	54	31	17	105

centrifuges, separators	0	33	29	42	104
process freezing / freeze drying	2	11	27	65	105
heating (HVAC)	1	77	21	9	108

Respondents are then asked if the importance of managing energy consumption of electricity and gas in the next 5 years will be:

More important	74%
Same	25%
Less important	0%
Don't know	1%

The reasons to support the response given above:

Need to reduce costs to remain competitive	67%
Total energy used will increase	62%
Natural gas prices will increase	52%
Electricity prices will increase	52%
Equipment will be replaced	34%
Planning expansion	34%
Efficiency measures have been implemented	33%
Not possible to use less energy	15%
Electricity prices will decrease	8%
Total energy used will decrease	2%
Planning to close the plant	0%
Natural gas prices will decrease	0%

Statistical Analysis of Energy in the Future

74% of the respondents agreed that energy management would be more important in the future.

The Dairy sector expected an increase of energy use for solid waste disposal and treatment ($p<0.05$), water disposal and treatment ($p<0.01$), overall air quality ($p<0.10$), pasteurizing ($p<0.01$), pumping ($p<0.01$), centrifuges ($p<0.01$), and conveying ($p<0.01$).

The Fruit and Vegetable sector expected energy for pasteurization/sterilization to increase ($p<0.01$).

The Beverage sector reported that they would use more energy for overall air quality ($p<0.10$), pumping ($p<0.01$), conveying ($p<0.10$ lighting ($p<0.05$), and heating ($p<0.05$).

The Dairy and Beverages sectors were expected to increase total output.

The Miscellaneous Prepared Foods sector predicted they would use more energy for water disposal and treatment and centrifuges ($p<0.01$).

There was a correlation between large companies and use of energy for pasteurization, automation, and proprietary technologies ($p<0.10$).

Large electricity end-users anticipated increases of energy for water disposal and treatment ($p<0.10$), pasteurization ($p<0.01$), process freezing and freeze-drying ($p<0.10$), and proprietary technologies ($p<0.05$).
Those respondents that indicated rapid growth in their sector were also most likely to check energy increases in all areas ($p<0.01$) except for water treatment and air treatment.

Companies with high growth rates also indicated that their energy requirements for total output would be increasing ($p<0.05$).

The Dairy sector and the Fruit and Vegetable sector were most likely to be planning an expansion.

Large companies were more likely to believe that reducing total costs was important to remain competitive ($p<0.05$), as did companies that were high energy users ($p<0.01$).

Small energy users believe that it is not possible to use less energy per unit product than they already do ($p<0.01$).

C. TECHNOLOGY

A list of technologies was provided and respondents were asked to indicate the current use, a use increase, a use decrease, or future use over the next 5 years.

TECHNOLOGY	DECREASE	CURRENT	INCREASE	FUTURE
Variable frequency drives	0	57	56	0
Microprocessors	0	50	47	4
Robotics	1	17	13	17
Reverse osmosis	1	17	13	13
Fumigation	2	16	6	4
Ultrafiltration	0	16	12	10
Proprietary processes	0	15	18	0
Aseptic packaging	1	14	18	6
Sensors	0	13	13	0
Dissolved air flotation	1	12	3	11
SCADA systems	0	10	8	2
Packaging	0	9	14	3
Ozonation	2	8	5	10
Microwave/radiofrequency	1	8	6	5
Freeze concentration	1	6	4	3
Induction heating	0	6	6	3
Ultra high pressure	1	4	4	1
Irradiation	0	3	2	8
Written pole motors	0	2	0	3
Ohmic heating	1	2	2	5
Pulsed electric field	1	2	1	3

Respondents were then asked to write in the most valuable new technology added to their facility in the last 4 years. Below is a list of the write-in responses grouped according to type of benefit:

Total Number Responses: 75

Energy efficiency (29) 37%
variable frequency drives (8)
programmable logic controllers (4)
Substation (2)
economIzers added to boiler system
boiler combustion control
High efficiency steam boiler
shut down boiler house, co-gen produces steam
SCADA system
controller-based load shedding
computer run energy usage
environmental control systems, temp, humidity
touch-screen computer control loops
CPU (V)
tank insulation
electronic soft starts
thermal oxidizer

Automation of Labor (19) 25%
automating with microprocessors & sensors
automated control systems
microprocessors (2)
laser sorter
color sorting (2)
electronic color sorting
optical sorting technology
optical product portioning and sorting
automated meat processing equip
drying automation
automated brewhouse
automated cheese vats & blockformers
robotics
electronic inspection of product
information system
automation of manual processes
plant automation

Regulatory Compliance (11) 15%
RO & UF membranes (2)
Membranes
nanofiltration
water reduction or re-use program
caustic recovery system
cyclone starch recovery system
bioenergy reduction system to reduce BOD, generates fuel for boilers
ammonia systems for freezing
emissions monitoring system
ion exclusion process

Preservation by heat treatment (9) 12%
tube in tube heat exchanger

steam pasteurization
HTST control & recorder
induction heating
TVR evaporation
aseptic process
aseptic filler
aseptic
dryer capacity

Packaging (9) 12%
aseptic packaging equipment (2)
cryopac
cryovac packaging for produce
automated packaging
robotics in packaging and pan storage
automated pkg.
packaging equip
self pouch packaging system

Mechanical Processing (7) 9%
high shear mixing equipment
extruder
new design centrifuge
processing our own raw material
new plant 96
ice machine
juice plant

Other (3) 5%
NFC Bulk Silo
Proprietary

The respondents were then asked to check a number of boxes that listed some benefits that the new technology (list above) provided.

Cost reduction	31%
Improved product quality	25%
Increased energy efficiency	16%
Increased throughput	15%
Regulatory compliance	8%
Reduction in water use	5%

Statistical Analysis for Technology

There is very little relationship between technology and SIC sector, except for dissolved air flotation, which was correlated to dairy and fruit and vegetable processors ($p<0.025$). Dissolved air flotation also correlated to large energy bills ($p<0.05$).

Robotics ($p<0.05$) and microprocessors ($p<0.05$) are more common in companies with high energy bills.

Microprocessors are slightly more common with companies that have a growth rate of 10% or greater ($p<0.05$).

Ultrafiltration was more common among large companies ($p<0.10$). Ultrafiltration and fumigation were slightly more common among companies with a growth rate of 0-2% ($p<0.10$).

Adding a new technology in the past 4 years which was related to energy efficiency was slightly more common in companies with high growth rates ($p<0.010$).

Cost reduction was the most frequent benefit of the new technologies among companies with over 500 employees and energy bills over $1 million ($p<0.05$).

Adding technology to improve energy efficiency was slightly more prevalent in companies with a higher percentage of product cost due to energy ($p<0.05$).

Technology added to meet regulatory compliance was strongly related to whether the company was a large natural gas user ($p<0.01$), and also related to the size of the electric bill ($p<0.05$).

Technology Ranking Assessment

Technologies from the survey are listed below from the highest to lowest number of respondents. This is a qualitative tool that makes it easier to see whether the technologies appear more often as current, increasing (developing) or future technologies. Some technologies are listed twice because there were the same number of responses in each column.

Current technologies	Increasing	Future
Variable Frequency Drives	Proprietary processes	Robotics
Microprocessors	Aseptic packaging	Reverse Osmosis
Robotics	Sensors	Dissolved air flotation
Reverse Osmosis	SCADA systems	Ozonation
Fumigation	Packaging	Irradiation
Ultrafiltration	Induction heating	Ohmic heating
Sensors	Ultra high pressure	Written pole motors
Dissolved air flotation		Pulsed electric field
SCADA systems		
Packaging		
Ozonation		
Microwave/radiofrequency		
Freeze concentration		
Induction heating		
Ultra high pressure		

D. POWER RELIABILITY

The survey asked each respondent to estimate the number of unexpected power "incidents" in the last year and then to estimate a total cost for these "incidents". An incident was defined as a fluctuation or interruption. Respondents were asked not to include interruptions that were part of an interruptible rate program, since these are voluntary and result in reduced energy rates.

Eleven of the respondents checked the box "DON'T KNOW". The remaining 98 ventured estimates for a collective total of 810 incidents and a range of 0-300 incidents. The following break down shows the number of responses and the corresponding number of incidents.

Number of Incidents	Responses
300	1
20+	3
11-20	8
6-10	14
5	10
4	12
3	15
2	11
1	8
0	5

If the response of 300 is treated as an outlying exception and not included in the total, the average number of these incidents for the remaining 97 responses can be calculated as 510/97=5.2 incidents annually per survey.

Of those reporting incidents, 62 respondents ventured a write-in estimate of their costs from these incidents. Without including an outlying claim of $15 million in associated costs, the total of the costs reported is $4,295,000, from 61 respondents for an average cost per site of $70,409.

The respondents were asked to check the most common cause of power fluctuations given the following four choices and a place to write-ins answer with the following results. An error identified in this survey question is the omission of whose equipment is malfunctioning, (utility or energy customer) making it impossible to know who had the "equipment malfunction".

poor quality from supplier	44%
equipment malfunction	36%
don't know	20%
harmonics	0%

Write-in responses that explain causes of power fluctuations

No Fault (26)

downed or damaged power lines & poles (2)
power outages, brown or blackout (2)
accidents (8)

weather (8)
nature (5)
acts of God

Utility Load Management (6)
interruptible rates
interruptions
scheduled off time
power curtailments by PGE
hot weather capacity low
high demand

Utility Equipment (6)
SCE equipment
transformer malfunction or transformer failure
maintenance with local distribution system
transmission line maintenance
line problems serving Lodi
utility

Plant Management (5)
variable use
electrical maintenance, power surge
materials fell on breaker box
vandalism
standby generation operation costs

The next question asked the respondent to check all the actions taken at their company to avoid costs from power interruptions. The following responses were tabulated:

Consulted with utility representation	42%
Uninterruptible Power Supply (UPS)	37%
Standby generator	27%
Back-up batteries	21%
No action	20%
Filed a claim with utility	19%
Voltage regulator	14%
Hired consultant	5%
Static transfer switch	4%
Motor generator	3%
Don't know	1%

Write-in responses for actions taken to avoid costs from power interruptions
UPS and backup for computers only
negotiating hook up with new supplier, Woodbridge Irrigation District
switched from PG&E to MID (Merced Irrigation District)
isolation transformers
automatic load shedding to reduce power consumption during utility outages
heat consultant
secured breaker box
upgrade main switch gear
new switching gear
trained staff for quick response
send employees home when power out

Statistical Analysis of Power Reliability

Out of the 25 respondents who reported more than 5 incidents per year, were not strong correlated with any variables other than slow growth ($p<0.05$).

The use of an uninterruptible power supply (UPS) was more common with large energy users ($p<0.001$), as were standby generators ($p<0.03$) and back-up batteries ($p<0.03$).

Consulting with utility representatives was more common in large companies ($p<0.05$) and in companies which were large energy users ($p<0.05$).

Respondents who filed a claim for a power interruption were more likely to be high natural gas users ($p<0.04$).

Companies who reported "no actions" were smaller companies ($p<0.01$) or energy users with bills in the lower ranges ($p<0.04$).